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AUTHOR	Sloan, Tina Rye; Vinson, Beth; Haynes, Jonita; Gresham, Regina
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ABSTRACT

This study examined the effectiveness of a methods course in the reduction of mathematics anxiety levels among three groups of preservice teachers majoring in elementary education. The sample included 61 novices enrolled in a course entitled Mathematics for the Young Child. This methods course utilized concrete manipulatives and active learning approaches. At the beginning of each quarter, prior to instruction, preservice teachers completed the Mathematics Anxiety Rating Scale (MARS), a 98-item, Likert-type questionnaire. They completed it again at the end of the 10-week course. The MARS asked students to rate anxiety levels related to several everyday life and academic situations pertaining to mathematics. Study materials included concrete manipulatives. The study also involved questionnaire-guided narrative interviews. Data analysis indicated that the methods course was able to significantly reduce the math anxiety levels of student teachers. Personal interviews revealed that many students attributed their reduction in anxiety to the methodology and inviting atmosphere of the course. Math anxiety reductions were significantly different in each group studied. For a few students, anxiety increased because the manipulatives were unfamiliar and intimidating. (Contains 5 tables and 34 references.) (Author/SM)

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Running head: MATH ANXIETY

ED 417 137

A Comparison of Pre-and Post- Levels of Mathematics Anxiety Among Preservice Teacher Candidates Enrolled in a Mathematics Methods Course

Tina Rye Sloan, Ed.S.
Beth Vinson, Ph.D.
Jonita Haynes, Ph.D.
Regina Gresham

Athens State College
200 McCain Hall
Athens, Alabama 35611

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T. Sloan

Paper presented November 12-14, 1997 at the annual meeting of the MidSouth Educational Research Association in Memphis, TN

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ABSTRACT

The present study examined the effectiveness of a methods course in the reduction of mathematics anxiety levels among three groups of preservice teachers majoring in elementary education. Statistically significant reductions in mathematics anxiety were obtained ($p<.0001$). The sample included 61 novices enrolled in a course entitled *"Mathematics for the Young Child"* at Athens State College, Athens, Alabama. Preservice teachers completed the Mathematics Anxiety Rating Scale (MARS), a 98-item, Likert-type questionnaire during the initial and final phases of the 10-week course. In addition, questionnaire-guided narrative interviews were conducted. Results at posttreatment suggested that a mathematics methods course which emphasizes conceptual learning through manipulatives can be instrumental in reducing the mathematics anxiety levels of future teachers.

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Introduction

Math anxiety is an irrational fear of mathematics and can range from a simple discomfort associated with numerical operations to total avoidance of math and math classes (Mathison, 1977). Richardson and Suinn (1972) have defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems" (p.551).

Math anxiety has been proven to be wide-spread among existing and preservice elementary teachers. In a study of four math anxious groups at the University of Minnesota in 1985, Kelly and Tomhave revealed that elementary education majors received the highest scores (230.0) on the Math Anxiety Rating Scale (MARS test) than any other group with the exception of those participating in a math anxious workshop. Wright and Miller (1981) concluded that math anxiety is prevalent among persons who perceive mathematical skills as inadequate in comparison to their abilities in other subjects. Unfortunately, many elementary education majors have an inadequate math background. According to Kelly and Tomhave (1985), only 6 out of 43 elementary education majors at the University of Minnesota had gone beyond college algebra in their mathematics preparation.

Significance of Problem

Research has shown that math anxiety is widespread among teacher candidates (Kelly & Tomhave, 1985). In a meta-analysis of 151 studies of math anxiety, Hembree (1990) reported that students preparing to teach in the elementary schools maintain the highest levels of math anxiety (243.0) as compared to other college majors. Considering the results of studies which indicate that teachers transmit this construct from one generation to the next (Kelly & Tomhave, 1985; Van de Walle, 1973), the researcher sought to investigate the prevalence of math anxiety among undergraduates at Athens State College, Alabama and explore methods of reducing math anxiety levels.

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Research Hypothesis

Ho There will be no significant reduction in math anxiety scores among preservice elementary teachers after exposure to a mathematics methods course which incorporates concrete manipulatives.

Ha There will be a significant reduction in math anxiety scores among preservice elementary teachers after exposure to a mathematics methods course which incorporates concrete manipulatives.

Definition of Terms

Math Anxiety will be operationally defined as the score obtained from the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972).

Preservice Teachers will include elementary education and special education majors classified as either juniors or seniors.

Concrete Manipulatives include materials for mathematical concept development such as geoboards, Cuisennaire rods, base-ten blocks, pentominoes, tangrams, uni-fix cubes,etc.

Review of Related Material

Review of the Literature

In an effort to examine the construct of math anxiety, the researcher conducted a review of the literature which addressed the following questions.

1. Who experiences math anxiety?
2. Is math anxiety related to other constructs?
3. How do teacher attitudes and anxieties affect students' achievement and anxiety levels?
4. What are some methods classroom teachers could utilize to prevent math anxiety?
5. What intervention strategies have been utilized to reduce math anxiety levels in college students?

Who experiences math anxiety?

Many studies have been conducted to determine who experiences the effects of math anxiety. Betz (1978) reported that females were generally more anxious than males. When math anxiety levels were compared among traditional and non-traditional age women, Betz found that the older females exhibited higher levels of math anxiety. Also, students with inadequate math backgrounds in high school and students with low achievement scores indicated higher levels of math anxiety. Research conducted by Calvert (1981), supported many of the same determinants of math anxiety. Calvert's study which involved students enrolled in a precalculus class at Black Hawk College in Illinois revealed that females, students who had taken only general mathematics courses, and students who received a grade of "C" or below in previous math classes tended to possess higher levels of math anxiety. Llabre and Suarez (1985) also reported higher anxiety levels among female participants.

Widmer and Chavez (1982) disputed the relationship between gender and math anxiety in a study which examined math anxiety in relation to gender, career inhibition, type of training, and recency of training. Their study of elementary school mathematics teachers indicated no significant relationship between gender and math anxiety. Based on the data collected at the University of Missouri, Richardson and Suinn (1972) found no significant difference in mean scores among male and female participants. In an effort to explain gender-related anxieties, Mathison (1977) noted that math was once viewed as a male domain where females were not encouraged to take higher level math courses; therefore, females often developed math anxiety. This cultural link of gender and math anxiety was addressed by Wright and Miller (1981); the researchers noted that often by the age of 13, many women are conditioned that mathematics is not a feminine pursuit and subsequently develop an anxiety toward math. Other researchers such as Dew, Galassi,

and Galassi (1983),who examined the presence of mathematics anxiety in 769 college students, concluded that gender differences in relation to math anxiety do exist, but are probably not as significant as stated in previous studies.

In relation to other college majors, preservice teachers reported the highest average math anxiety score (243.0) as measured by the Math Anxiety Rating Scale (Hembree, 1990). Other studies have substantiated this finding. Kelly and Tomhave (1985) indicated that elementary education majors reported the highest scores (230.0) of math anxiety with the exception of those participating in a math anxious workshop.

Is math anxiety related to other constructs?

Researchers have investigated the relationship between math anxiety and various constructs such as general anxiety, intelligence, personality, learning approaches, test anxiety, and math achievement. In one study, Llabre and Suarez (1985) investigated the relationship between math anxiety and course grades in an introductory algebra course using a sample of 112 college women and 72 college men at a private university. The math course was designed for students who have had less than two years of high school mathematics. Using the revised version of the Math Anxiety Rating Scale, the researchers determined that the level of math anxiety did not always serve as a predictor of how well students would perform in a math course.

In an investigation of the relationship between test anxiety and math anxiety, researchers determined that the two constructs were related to a degree, but they were not synonymous (Dew, Galassi, and Galassi, 1983). Using a factor analysis of the Mathematics Anxiety Rating Scale (MARS), State Trait Anxiety Inventory (STAI), Suydam-Trueblood Attitude Toward Mathematics Scale (MAS), Askov-Trueblood

Attitude Toward Reading Scale (RAS), and Test Anxiety Inventory (TAI), the researchers (McAuliffe & Trueblood, 1986) conducted a study of the interrelationship among several constructs with 138 preservice elementary and special education teachers who were enrolled in two 10-week methods courses with a five-week field experience immediately following. Findings indicated that mathematics anxiety, general anxiety, test anxiety, and math attitude are all interrelated constructs. In a study of factors associated with types of mathematics anxiety in 73 college students enrolled in an introductory statistics class, Bessant (1995) determined that math anxiety is indeed a multidimensional construct often linked to learning approaches, attitudinal dispositions, and learning preferences.

A recent study, conducted by Hadfield and McNeil (1994), investigated the relationship between personality and math anxiety. Using the Myers-Briggs Type Indicator with preservice elementary teachers enrolled in a teacher education program, the researchers sought to determine whether there was a link between one's personality and level of math anxiety. The ethnic composition of the study was 101 Anglo, 42 Hispanic, and 8 other from Afro-American, Native American, or Asian ethnic groups. The study revealed that the highest levels of math anxiety were among the ESFP personality types. " E" represents people who characterize themselves as extroverts who rely on the environment as their major energy source. Sensing (S) persons rely more on the senses to formulate ideas and have a tendency to focus on immediate experiences; they are usually viewed as realistic and practical. The Feeling (F) subscale describes those that depend on subjective values and feelings to make judgments. People characterized as (F) usually place a higher regard on the well-being of humans as opposed to technical aspects. Finally, Perceptive (P) people are curious and have little need for closure. In this research

study, ENTJ types maintained the lowest levels of math anxiety. "N" represents the intuitive types who focus on possibilities and insights. The Thinking (T) subscale describes those that seek a rational order based on logic. Judging (J) types seek closure and function best with organized plans. The researchers suggested that the ESFP types be identified and subsequently monitored for the detection and treatment of math anxiety.

Although math anxiety has been linked by some researchers to personality and anxiety in general, it has not been linked to intelligence (Hembree, 1990). Morris (1981) emphasized that it is often characteristic of people who are successful in other areas and can usually be traced to a negative experience in elementary school.

How do teacher attitudes and anxieties affect students' achievement and anxiety levels?

Schofield (1981) was one researcher who investigated the effects of teacher ability and attitude on students' achievement/attitudes. This research revealed some interesting conclusions. Pupils of high achieving teachers demonstrated the highest degrees of mathematical achievement, but these pupils exhibited the least favorable attitudes toward mathematics. In contrast, the pupils of middle and low achieving teachers had the most favorable attitudes toward math, yet maintained lower achievement scores. The study also revealed that teachers with positive attitudes had higher achieving pupils.

Other findings which supported the link between student achievement and teacher attitude have been conducted by Furcito (1982) and Van de Walle (1973). Furcito's findings revealed that teaching strategies designed specially to foster positive self-concepts and attitudes were instrumental in reducing math anxiety levels and fostering student achievement. In Van de Walle's investigation of the relationship between perceptions held by 122 elementary teachers and 3100 students, a direct link was noted between teachers' positive perceptions/attitudes and students' mathematical comprehension.

In an investigation of the possible link between teaching strategies and the transmission of math anxiety to students, Bush (1989) studied 31 upper elementary teachers with various levels of math anxiety as measured by the Mathematics Anxiety Rating Scale. The findings from this study refuted an earlier claim concerning the correlation of teacher's levels of math anxiety and changes in students' math anxiety levels (Kelly & Tomhave, 1985). Bush noted that no significant relationship was found between teacher and student mathematics anxiety. Using the 98-item Mathematics Anxiety Rating Scale (MARS), the researcher did determine that teachers with higher levels of math anxiety had a slight tendency to be more traditional in their teaching style by devoting more time to seatwork and whole-class instruction; they often devoted less time to playing games, problem solving, and small-group activities. In addition, teachers with higher levels of math anxiety usually taught more skills and fewer concepts.

Teaching strategies were also investigated by Widmer and Chavez (1982) whose findings did support earlier studies (Betz, 1978; Calvert, 1981) concerning a positive relationship (.05 level) between math anxiety and teaching methodology. Their study revealed that students whose mathematics background consisted of an emphasis on understanding were significantly less anxious than their counterparts.

What are some methods classroom teachers could utilize to prevent math anxiety?

Based on the premise that many math anxious people tend to become math avoiders and subsequently limit career choices, researchers have sought to determine methods to reduce or even prevent math anxiety. Morris (1981) provided several strategies that teachers could utilize to prevent math anxiety: (a) creating a positive inviting learning atmosphere, (b) stressing the thought process rather than the product, (c) dispelling the myth that only certain people can perform math well, (d) providing positive math experiences, (e) utilizing concrete manipulatives in all elementary grades, (f) teaching

mastery of concepts prior to introducing new concepts, and (g) providing positive comments on written assignments.

In an article concerning modifications to reduce math anxiety levels among students, Sherard (1981) agreed that sex role stereotyping of mathematics as a male domain should be avoided; the author advocated that teachers share the same expectations for success and achievement among both males and females. Sherard agreed with Morris' (1981) position that teachers should emphasize problem solving as a vital aspect of the mathematics curriculum. Additional strategies provided by Sherard included: (a) relating the practical aspects of mathematics to everyday life, (b) developing self-confidence by encouraging students to trust their own intuitions, (c) teaching in a flexible manner which emphasizes many solutions and methods for solving problems, (d) utilizing a variety of methods for evaluation, (e) avoiding humiliating experiences such as forcing them to work problems alone at the chalkboard, and (f) providing a supportive classroom where students have many opportunities for successful experiences.

What intervention strategies have been utilized to reduce math anxiety levels in college students?

Based on the prevalence of math anxiety among preservice elementary teachers, several studies have been conducted for the purpose of reducing math anxiety levels within this population. One study was conducted by Sovchik, Meconi, and Steiner (1981) at the University of Akron with 59 students enrolled in a mathematics methods course. The results of this study indicated a statistically significant reduction in mathematics anxiety as measured by the Mathematics Anxiety Rating Scale (MARS) after exposure to a mathematics methods course. Another study conducted by Battista (1986) reported similar reductions in math anxiety levels as a result of a math methods course which emphasized a five-week field experience, small group activities, and concrete materials. Conclusively, Teague's (1981) study revealed a significant reduction in anxiety levels

after exposure to a math methods course, yet attitudes toward mathematics were not reduced significantly. The effects of a methods course on reducing preservice teachers' math anxiety levels have been substantiated by many researchers (Alsup, 1996; Bullock, 1996; Harper, 1995; Lynch, 1996).

Remedial math instruction and individualized tutoring have also been utilized with preservice teachers to reduce math anxiety levels as well as enhance attitudes toward math. Based on a study involving 26 junior and senior elementary education majors from the University of Montevallo, Tishler (1980) reported that preservice teachers' attitudes were not affected significantly as a result of a 13-week treatment of remedial instruction, but a positive change in mathematics achievement scores were obtained. A similar study was conducted by Kontogianes (1973). The researcher studied the effects of achievement, retention of information, and attitude among preservice elementary school teachers through an individualized mathematics program. The self-paced program allowed students to attend lectures, participate in small group sessions, and receive individualized tutoring from the professor. In this study, the researcher reported a significant gain with respect to math achievement scores and retention of math concepts. However, the participants did not experience a statistically significant change in attitude.

Based on the assumption that math anxiety is related to mathematics achievement, Clute (1984) conducted a study of 38 males and 43 females enrolled in a mathematics survey course. This particular course was not remedial in nature; it was designed to teach logical, problem-solving, and critical- thinking skills. The study investigated the relationship between mathematics anxiety and instructional method and the subsequent effect on mathematics achievement. The level of anxiety was determined by the Mathematics Anxiety Rating Scale with subjects categorized with either high, medium or low levels. Two approaches, discovery and expository were utilized by the instructors in the different sections of the survey course. The discovery approach was characterized by

questioning sequences that promoted the discovery of mathematical principles while the expository approach was designed to incorporate a series of lectures. Findings from this study indicated that groups with a high degree of math anxiety perform better when taught using the expository method; the discovery method worked best with low to medium levels of math anxiety. The study revealed that students with low levels of math anxiety consistently outperformed those with higher levels on a mathematics achievement test.

Chapline (1980) discussed other academic interventions for math anxiety reduction. The author described a model program known as the Teacher Education and Mathematics (TEAM) Project which was designed to (a) reduce preservice teachers' math anxiety levels, (b) develop an awareness of gender-bias in math courses and curriculum materials, and (c) increase the knowledge base of mathematical skills and concepts. Components of the program included inductive approaches to problem-solving, test preparations designed to reduce anxiety, and student logs of their attitudes and perceptions. The TEAM Project revealed significant gains in mathematical concepts and reduced anxiety scores among participants as measured by the Math Anxiety Rating Scale.

In an effort to combine both academic/affective interventions, Kostka and Wilson (1986) conducted a study which consisted of eleven 2-hour group meetings. The first hour was designed to address mathematical deficiencies and skills; the second hour focused on stress/anxiety reduction. Participants were nontraditional female students ages 25-47 at West Virginia University. Based on the pretest and posttest scores of the Math Anxiety Rating Scales (MARS), participants averaged a reduction in anxiety levels of 100 points. A similar study conducted by Hendel and Davis (1978) combined a 3-hour diagnostic clinic, three special mathematics courses, and a support group which was led by a counselor as intervention strategies for 69 adult women returning to college. The study revealed that enrollment in both the mathematics courses and participation in a counseling group were the most effective in decreasing the math anxiety levels of the participants.

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Other attempts to address math anxiety through psychological means include systematic desensitization and hypnotherapeutic restructuring. Systematic desensitization, using behavioral therapy and deep muscle relaxation, was administered to a group of preservice elementary teachers enrolled in a mathematics methods class by Olson and Gillingham (1980) to treat math anxiety. Participants were chosen based on results from the Mathematics Anxiety Rating Scale. Significant reductions in math anxiety levels were obtained as a result of systematic desensitization, yet no significant changes were reported with regard to preservice teachers' attitude. In a similar study of college students, Trent (1985) noted the effectiveness of both hynotherapeutic restructuring and systematic desensitization as treatment programs for mathematics anxiety. The study revealed that during a 6-week period, both methods were influential in reducing math anxiety. Only hypnotherapeutic restructuring was significantly effective in improving mathematics attitude and performance.

Additional relaxation techniques have been investigated as methods to reduce math anxiety. One such study was conducted by Bander, Russell, and Zamostny (1982). The researchers utilized cue-controlled relaxation techniques, math study skills training, and a combined program of both with 53 students enrolled in an introductory psychology course. Cue-controlled relaxation, which consisted of training in deep muscle relaxation and association with a self-induced cue word, was determined to be the most effective in reducing the level of mathematics anxiety and enhancing mathematics performance.

Summary

Based on the research conducted, few theories were conclusive. One unanimous finding is that high levels of math anxiety are present and prevalent among preservice elementary teachers (Battista, 1986; Bush, 1989; Kelly & Tomhave, 1985; Sovchik, Meconi, & Steiner, 1981). Second, research has conclusively shown that there is no relationship between intelligence and mathematics anxiety (Hembree, 1990; Morris, 1981).

Several cognitive and affective intervention strategies have been proven to reduce math anxiety levels. Using the cognitive approach, math methods courses have proven to be instrumental in reducing math anxiety levels among undergraduate teacher candidates by researchers (Alsup, 1996; Battista, 1986; Bullock, 1996; Bush, 1989, Harper, 1995; Lynch, 1996; Sovchik, Meconi, & Steiner,1981). Behavioral therapy sessions which utilize psychological techniques have been reported to actually reduce math anxiety levels significantly (Bander, Russell & Zamostny, 1982; Hendel & Davis, 1978; Kosta & Wilson, 1986; Olson & Gillingham, 1980; Trent, 1985).

Although math anxiety levels have been consistently reduced as a direct result of methods courses, math attitudes have not been steadily enhanced. For example, Teague (1981) revealed that attitudes were not significantly affected in spite of the reduction in math anxiety levels. Tishler (1980) also reported that student attitudes were not substantially altered after a 13-week treatment.

While investigating previous studies, the researchers discovered several findings that were inconclusive. The relationship between gender and math anxiety was debated among several researchers. Betz (1978), Calvert (1981), and Llabre and Suareaz (1985) advocated that math anxiety levels were significantly higher among females, yet findings from studies conducted by others (Dew, Galassi, & Galassi, 1983; Richardson & Suinn, 1972; Widmer & Chavez, 1982) revealed no significant differences between male and female math anxiety levels.

Other topics of debate included the relationship between teacher attitudes toward mathematics and their subsequent effect on students. Scholfield (1981) indicated that high achieving teachers did seem to have high achieving students. Unfortunately, those students had the lowest attitudes toward math. In the same study, teachers who were classified as middle to low achievers in math had students who performed lowest on achievement measures, yet these students indicated having the best attitudes toward math. Schofield

did find a positive relationship between teachers with positive attitudes and high achieving pupils. Van de Walle (1973) also found a direct link between teachers' positive perceptions and attitudes toward math and students mathematical comprehension.

The relationship between teaching strategies and the transmission of math anxiety to students has been another controversial topic. Evidence supporting the relationship between teachers math anxiety and subsequent student anxiety levels was made by Kelly and Tomhave (1985). In contrast, Bush (1989) found no significant correlation between teachers' anxiety levels and those of their students.

The research conducted conclusively found that math anxiety levels are indeed high among preservice teachers, yet levels can be significantly reduced among participants of various backgrounds, ages, and cultures. Based on this information, the researcher designed the present study of investigation.

Methodology

In light of the prevalence of math anxiety among many preservice teachers, the present researcher sought to discover methods to reduce the math anxiety levels in preservice teachers through an investigation of cognitive interventions within the context of a math methods course. The primary objectives of the methods course are for preservice teachers to be able to (a) demonstrate knowledge of mathematics content; (b) plan developmentally appropriate lessons for all K-3 students; (c) develop lessons based on various learning styles, cultural backgrounds, and exceptionalities; (d) develop techniques, strategies, and activities that promote problem solving and critical thinking skills; (e) implement computer technology into the mathematics curriculum; (f) teach a primary mathematics lesson to a small group of peers; and (g) demonstrate and select appropriate manipulative materials.

Subjects. The subjects of the study were 61 preservice elementary teachers enrolled in a 10-week mathematics methods course entitled Math for the Young Child taught by the

researcher at Athens State College in Athens, Alabama. The study was conducted during three distinct 10-week sessions to include the Fall, Winter, and Spring quarters with 20 to 21 students participating each quarter. Participants were classified as either junior or senior level undergraduates majoring in elementary education or special education.

Athens College is a public (state) institution located in the city of Athens, a rural area in north-central Alabama. Athens College is unique in that the student population consists exclusively of students with junior or senior level classification. The undergraduate enrollment for 1995-1996 was 1,316. Unlike other institutions of its class, full-time students at Athens College constitute only 46% of the total student body. Of the full-time undergraduates, women comprise 65% of the enrollment. The ethnic composition includes 7% African-American, .6% Hispanic, .7% Asian, and .8% Native American. The preservice teacher population consists primarily of non-traditional age students, with a high percentage of Caucasian females. The Teacher Education Program at Athens State College is accredited by the National Council for the Accreditation of Teacher Education.

Materials/ Instrumentation. The Math Anxiety Rating Scale (Richardson & Suinn, 1972) was used to measure the initial and post treatment levels of math anxiety. The MARS is a 98-item instrument consisting of brief everyday life and academic situations pertaining to mathematics. Participants were asked to respond to the level of anxiety associated with each item. The instrument has a Likert scale with a range of 1 (no anxiety at all) to 5 (a great deal of anxiety). Scores range from 98 to 490, where the higher scores correlate with higher levels of math anxiety. Based on a sample of 397 undergraduates, Richardson and Suinn (1972) reported that test-retest reliability coefficients were .78 over a 2-week period and .85 over a 7-week period with an internal consistency coefficient of .97. Richardson and Suinn indicated the norm mean score for the adult form of the MARS as 215.38.

Evidence of validity was based on research which correlated the MARS with the Differential Aptitude Test (DAT). Correlations were reported to be -.35 ($p < .05$) initially with retesting reported at -.32 ($p < .05$). Negative correlations between anxiety and mathematical aptitude were expected (Suinn, Edie, Nicoletti, & Spinelli, 1972). Based on the research of validity and reliability, the MARS instrument was chosen to measure mathematical anxiety levels among junior and senior level methods students at Athens State College.

Other materials in the study included concrete manipulatives. Examples of manipulatives utilized during the treatment phase include base-ten blocks, geoboards, attribute blocks, pentominoes, tangrams, geometric solids, graph paper, tactile numeral cards, decimeter squares, pattern blocks, fraction pieces, calculators, walk-on number lines, and uni-fix cubes. The manipulatives were incorporated in a conceptual manner with techniques, strategies, and activities aimed at the K-3 mathematics curriculum. Math lessons addressed prenumber concepts, number concepts, numeration, place value, geometry, time, money, length, capacity and volume, weight, temperature, estimation, area, problem-solving, graphing, fractions, as well as addition, subtraction, multiplication and division of whole numbers.

Data Collection. At the beginning of each quarter prior to instruction, the researcher administered the 98-item Math Anxiety Rating Scale to 61 preservice teachers enrolled in a mathematics methods course entitled Math for the Young Child. Two sections of the course were taught during the Summer Quarter of 1996; one section was taught during the subsequent Fall Quarter. The course syllabi and methodology presented to the three groups were similar and taught by the researcher. At the conclusion of the 10-week quarter, the same instrument was administered as a posttest.

Data analysis procedures. PreMARS and PostMARS scores were obtained by multiplying the degree of math anxiety represented on the Likert scale with the number of responses.

Subsequently, these scores were totaled for a possible range of 98 to 490. Pretest and posttest scores were then compared on an individual basis by subtracting initial and post intervention MARS scores. Tables 1-3 provide individual pretest, posttest, and difference scores. A negative difference indicates a reduction in math anxiety levels while a positive score reveals an increase in math anxiety during the 10-week course. A mean difference for each group was also calculated. Comparisons between the mean pretest /posttest and average differences among the three groups are summarized in Table 4. A t-test was calculated using the combined results of all three groups to determine the degree of reduction in math anxiety levels among the group participants. Table 5 provides the t-test comparison of pretest and posttest raw scores which indicated a significant reduction in math anxiety levels ($p=.000022$), two-tailed.

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TABLE 1 PRETEST/POSTTEST MARS RESULTS SUMMER QUARTER GROUP A 1996

Subject Number	Posttest Scores	Pretest Scores	Difference
1	111	174	-63
2	111	122	-11
3	112	120	-8
4	264	321	-57
5	189	220	-31
6	115	144	-29
7	106	112	-6
8	104	123	-19
9	144	183	-39
10	106	150	-44
11	108	106	2
12	194	188	6
13	107	132	-25
14	150	171	-21
15	191	216	-25
16	383	336	47
17	120	230	-110
18	380	407	-27
19	116	148	-32
20	176	247	-71
21	185	199	-14
N=21			
Means	**165.3333333**	**192.8095238**	**-27.47619048**
Range	High (380)	High (407)	
	Low (104)	Low (106)	
	range = 276	range = 301	

MARS=Mathematics Anxiety Rating Scale Possible Range 98-490

TABLE 2 PRETEST/POSTTEST MARS RESULTS SUMMER QUARTER GROUP B 1996

Subject Number	Posttest Scores	Pretest Scores	Difference
22	201	226	-25
23	240	225	15
24	195	197	-2
25	125	215	-90
26	119	173	-54
27	278	275	3
28	131	176	-45
29	101	105	-4
30	220	208	12
31	183	218	-35
32	147	149	-2
33	187	232	-45
34	131	136	-5
35	176	202	-26
36	151	179	-28
37	294	217	77
38	118	133	-15
39	103	113	-10
40	278	290	-12
41	112	139	-27
N=20			
Means	**174.5**	**190.4**	**-15.9**
Range	High (294)	High (290)	
	Low (101)	Low (105)	
	range = 193	range = 185	

MARS=Mathematics Anxiety Rating Scale Possible Range 98-490

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TABLE 3 PRETEST/POSTTEST MARS RESULTS FALL QUARTER GROUP C 1996

Subject Number	Posttest Scores	Pretest Scores	Difference
42	254	303	-49
43	147	154	-7
44	148	152	-4
45	165	193	-28
46	177	247	-70
47	108	159	-51
48	120	123	-3
49	270	318	-48
50	118	151	-33
51	190	162	28
52	143	153	-10
53	172	235	-63
54	156	155	1
55	200	139	61
56	138	161	-23
57	171	158	13
58	143	167	-24
59	139	115	24
60	210	203	7
61	128	128	0
N=20			
Means	164.85	178.8	-13.95
Range	High (270)	High (318)	
	Low (108)	Low (115)	
	range = 162	range = 203	

MARS=Mathematics Anxiety Rating Scale Possible Range 98-490

TABLE 4

MATH ANXIETY GROUP COMPARISON SCORE MEANS

GROUP	POSTTEST	PRETEST	DIFFERENCE	VALID N
SUMMER 96 GROUP A	165.33	192.81	-27.48	21
SUMMER 96 GROUP B	174.50	190.40	-15.90	20
FALL 96 GROUP C	164.85	178.80	-13.95	20
ALL GROUPS	168.23	187.34	-19.11	61

TABLE 5

T-TEST COMPARISONS OF PRETEST AND POSTTEST SCORES

Significance Level = p<.05
******Indicates significant difference.**

VARIABLE	N	t	df	p
Pretest-Posttest	61	4.600603	60	.000022****

Results

The results of this study indicate that the methods course, which utilizes concrete manipulatives and active learning approaches, was able to significantly reduce the math anxiety levels of the participants ($p < .05$). As indicated by Tables 1 - 3, the mean mathematics anxiety level was reduced by 27.48 points with Group A, 15.90 points with Group B, and 13.95 points with Group C. High and low pretest scores were 407 / 106 (Group A), 209 / 105 (Group B), and 318 / 115 (Group C). Respective posttest scores were 380/104 (Group A), 294/101 (Group B), and 270/108 (Group C). Reductions in mathematics anxiety ranged from a high of 110 points with Group A, 90 points with Group B, and 70 points with Group C.

Conclusions and Future Research Needed

The present research study revealed that math anxiety levels were reduced as a direct result of exposure to a 10-week methods course. Personal interviews revealed that many students attributed their reduction in math anxiety to the methodology and inviting atmosphere of the course. Several students commented that they finally "understood" concepts such as fractions, decimals, and percents when the topics were presented in a concrete and practical format. Others commented that math was now less "foreign" to them, noting that perceptions of their abilities to understand mathematical concepts were now enhanced. The most unanimous and interesting comment was that the participants felt as though their math anxieties could have in fact been prevented in elementary school, if they had received instruction through concrete manipulatives.

During the quarter, some of the participants experienced an increase in their math anxiety levels. When questioned, students responded that some of the manipulatives such as the Cuisennaire rods were unfamiliar and intimidating, thereby enhancing anxiety levels. Another rationale for the increase included the requirement of teaching a lesson to a

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small peer group. For many students, this was their first methods course and only experience teaching a math lesson before a group.

Notably, the math anxiety reductions were significantly different in each group. On average, Group A experienced a 27.48 point reduction, while Groups B and C revealed 15.90 and 13.95 point reductions respectively. One explanation could be the population of each group. Group A was the only class taught during the day. Groups B and C were night classes with a large proportion of the population made up of nontraditional-age returning students and fifth year students from other professions. In contrast, Group A consisted primarily of students ages 20-24. Another possibility was that the initial levels of Group A were significantly higher than Groups B and C. The highest preintervention level was 407 in Group A, while high scores of 290 and 318 were reported among Groups B and C.

A final theory for the difference in math anxiety reduction levels is that one participant in Group A experienced a 110-point reduction (PreMARS score of 230 to a PostMARS score of 120). When reduction levels were averaged for each group, this extreme score affected the group total. The reason for the differences among the groups is probably a combination of these factors.

The limitations of the present study included the fact that the treatment was short-term in nature. Each quarter consisted of 10- week sessions with each session consisting of four clock hours.

In relation to mathematics anxiety, three recommendations are made for future research. First, additional research should be conducted regarding the probable link between learning styles and math. Some research has been conducted in this area (Bessant, 1985), yet this multidimensional construct should be investigated further to determine to what extent math anxieties could be prevented or present levels reduced through learning approaches and preferences. The second recommendation involves

investigating to what degree teaching performance is actually affected by the math anxiety levels of teachers. Since the research in this area is inconclusive, additional empirical studies should be conducted. The third and final recommendation is that additional research should be conducted to determine if there is indeed a strong correlation between personality and math anxiety. Based on Hadfield and McNeil (1994), personality as measured by the Myers-Briggs Type Indicator, was linked to math anxiety. Therefore, additional studies should be conducted for the purpose of matching methodology to learning preferences of various personality types in an effort to reduce or prevent the prevalence of math anxiety.

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